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Nonharmonic Bloch oscillations in GaAs/AlGaAs superlattices

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Bloch [1] and Zener [2] theoretically calculated that in the materials with a periodical potential in the case of applying the steady external electric field the electrons should move periodically. This periodical motion is called Bloch oscillations.

Bloch oscillation can be seen experimentally when the period of Bloch oscillation is longer enough than the relaxation time of electrons and holes. This condition may be made up in such structures as multiple quantum wells and superlattices. Four wave mixing (FWM) technique was used for investigation of Bloch oscillations in superlattices in [3]. It was shown that the resonant position of exciton lines in the spectrum of FWM signal displays the harmonic oscillation, which is caused by the changing of local internal electric field by the periodical motion of electron wave package. In [3] was also mentioned that the anticrossing of heavy hole and light hole excitons can lead to nonharmonic Bloch oscillation.

To investigate the nonharmonic Bloch oscillations we used spectrally resolved four

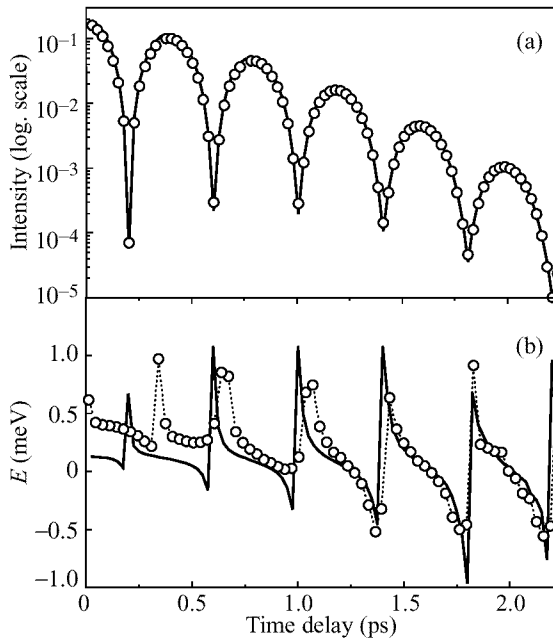


Fig 1. The experimental (open circles) and theoretical (solid line) dependencies of the intensity (a) and resonant position (b) of heavy hole exciton on the time delay

wave mixing technique. The superlattice with barriers of 17 Å and quantum wells of 97 Å was investigated. Our main experimental result is shown in Fig. 1 by opened circles. The nonharmonic Bloch oscillation (a) and beats of the intensity of heavy hole exciton line (b) we explained by the model of quantum beats of inhomogeneous exciton lines [4]. The results of our calculations are presented in Fig. 1 by solid lines. The very good agreement of theoretical calculation with experimental results proved the quite strong influence of inhomogeneous broadening on the Bloch oscillation of electron wave package.

References

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